PATENT SPECIFICATION (11) 1 500 801

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D1P J1

(54) WASHING

(71) We, BÖWE BÖHLER & WEBER KG, a German Company, of 8900 Augsburg, Haunstetter Str. 112, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

The invention relates to the washing of, for example clothing, bed linen, underwear and similar articles with water in a washing chamber.

A large number of laundering methods of this kind are known. They have the advantage that the cleansing liquid is relatively cheap, but they also have the disadvantage that a certain greying of the cleaned articles (so-called "retrograde washing") cannot be avoided by adding adjuvant substances, and dirt which contains oil and grease can be detached from the articles to be cleaned to an only inadequate extent or can be removed therefrom only with the aid of special washing aids which have to be added to the liquid. The waste water is contaminated with the grease and oil-containing dirt thus dispersed in the liquid and can be separated therefrom only with difficulty. In order to overcome these disadvantages, it is known to subject the articles to a preliminary cleaning with conventional solvents in a dry-cleaning machine before they are laundered in a washing machine. In order to avoid losses of solvent and poisoning of the environment on the transfer of the articles to the washing machine, the previously cleaned articles have to be completely dried before they are transferred to the washing machine.

A method of avoiding the substantial expenditure for equipment, and in order to save time and personnel, is to treat the articles with a mixture of solvent and water in the form of an emulsion or micellar solution. This method has succeeded in practice. However, in this known method a marked greying cannot be avoided even by extended rinsing. On the other hand, the detachment of water-soluble substances by means of the emulsified quantity of water produces unsatisfactory results.

British Patent Specification No. 812,894 discloses the finishing of textiles by passing a width of textile material through a bath of hot water (water seal). In this method, the bulk of the solvent is removed by conventional means, for example squeezing rollers, before the width of textile material enters the water bath. The water serves merely as a means of facilitating evaporation of residual traces of solvent.

In a method of dyeing textiles in a mixture of solvent and water disclosed in German Offenlegungsschrift No. 1,931,353, undesirable water-soluble additives still present on the articles previously dyed with the dye dissolved in the water are removed from the textiles in a bath of heated water after the dyeing liquid has been drained off. Apart from the fact that that Offenlegungsschrift does not relate to the removal of water-soluble dirt, the articles are, before application of the heated bath of water, impregnated with a mixture of solvent and water in which the additives referred to are dissolved. The rinsing has merely the effect of diluting the existing aqueous solution.

It is therefore an object of the invention to try to overcome the disadvantages of the known art and to provide a method and apparatus requiring little expenditure for apparatus and affording a saving in time and personnel, and ensuring an improved washing effect, a markedly reduced greying and an increased brightening while simultaneously avoiding contamination of the waste water with oil and grease.

According to the invention there is

provided a method of washing one or more articles selected from articles of clothing, bed linen, underwear and similar articles, comprising cleaning the one or more articles in a washing chamber with an organic solvent which is capable of forming an azeotropic mixture with water having a boiling point below that of water or itself has a boiling point below the boiling point of water, removing the bulk of the solvent, when in the same washing chamber the one or more articles, still wet with the solvent, in an aqueous liquid at a temperature above the boiling point of the solvent or above the boiling point of the azeotropic mixture, condensing the vapour evolved, and after separating any free water monitoring the rate of flow of the remaining condensate and continuing the washing until the flow drops below a predetermined value.

Thus using the method of the invention, the articles, before being wetted with water, are initially cleaned in the same washing chamber wih an organic solvent, preferably with a halogenated hydrocarbon, for example perchloroethylene or trichlorotrifluorethylene, which is capable of forming an azeotropic mixture with water having a boiling point below that of water or which has a boiling point below the boiling point of water, without additional water; the articles still moist with solvent are then washed in the same washing machine without having previously been dried, in an aqueous liquid provided with a detergent, for example an active washing substance, a polyphosphate and optionally with an optical brightening or bleaching agent, at a temperature above the boiling point of the solvent or above the boiling point of the azeotropic mixture, until substantially no solvent evaporates from the liquid. This condition can be readily determined by condensing the vapour rising from the liquid in a condenser and measuring the rate of flow of the condensate from the condenser after the removal of any free water. The washing step may be terminated as soon as this rate of flow drops below a predetermined value. This can be readily measured and evaluated with the aid of a flowmeter. The articles may then be spin-dried or centrifuged and subsequently be withdrawn from the machine. During the heating of the washing liquor, the solvent escapes therefrom as vapour when its temperature exceeds the boiling point of the solvent or the azetropic boiling point. Thorough laundering requires, in any case, a temperature in the range 90-95°C, and evaporation of the solvent is thus always ensured in the presence of the halogenated hydrocarbons generally used for solvent cleaning.

Thus, in a method embodying the invention there is an active washing step in which, the dirt-dissolving capacity of the solvent, still present in the articles from the preceding dry-cleaning step, increases with increasing temperature of the water.

As compared with the known methods of washing, the method embodying the invention results in surprisingly little greying and a considerably improved brightening of the articles to be cleaned, both as compared with the results obtained in exclusive dry-cleaning and exclusive laundering and also as compared with the method of cleaning in a mixture of solvent and water. A better washing effect is obtained. First of all, the heating during the laundering step has the effect of improving the dirt-solving capacity of the solvent which is deliberately left on the articles previously treated with the solvent. As a result, substances of low solubility in normal solvent cleaning without heating of the liquor, are detached from the articles and removed. It has also been found that in most articles of clothing the solvent adhering to the inside and outside of the fibre and the dirt present in the solvent are gradually dislodged from the inside and outside of the fibre by the water during the washing step before the boiling point is reached. Upon evaporation of these last traces of solvent, the residual dirt initially still present remains in dispersed form in the water instead of remaining in or on the fibre. The expenditure for apparatus, the consumption of time and the personnel requirements are considerably below those in separate dry-cleaning and laundering processes carried out in different machines. The fact that exclusive "dry-cleaning" — that is to say cleaning in a completely anhydrous solvent — is carried out before the actual laundering step and that upon subsequent laundering a portion of the solvent is still present on the articles and thus contributes to an improved washing effect upon heating, is essential to the advantageous results obtained by the invention, particularly the surprisingly slight greying and the improved brightening as compared with the results obtained by application of the known washing methods.

An as complete as possible evaporation of the solvent during the laundering step, even in short-time laundering, for example for cleaning articles which are only slightly dirty, may be ensured in that means are provided so that the pressure in the vapour space above the heated aqueous liquid is reduced during the period of laundering. Furthermore, the articles may be spun for a short time after the solvent has been drained from the washing chamber to reduce the amount of solvent to be

evaporated during the subsequent laundering step. However, basically this is not absolutely necessary. As mentioned previously, a brightening, bleaching or active washing substances, known *per se* may advantageously be added to the aqueous liquor to assist the washing effect.

In the accompanying drawing is shown a simplified block diagram of a machine suitable for carrying out the method of the invention.

In the drawing the run of the individual conduits is indicated merely by lines and the individual valves and other shut-off elements are indicated simply by a switch symbol *x*. It will readily be apparent which particular shut-off elements are open and which shut-elements are closed during specific operating steps so that it is unnecessary to mention this in the following description.

Referring to the drawing, a washing chamber 1 is normally constructed as a drum housing containing a rotatable drum to be loaded with the articles. The washing chamber 1 is provided with a steam jacket 2 for heating the liquid. Water or aqueous liquid is supplied through a conduit 3 and discharged through a conduit 4. A container 5 contains an active washing substance or the like to be introduced into the aqueous liquid.

At the beginning of the operational process, solvent from a solvent reservoir 6 is pumped by a pump 7 through conduit 8 into the washing chamber 1 which has previously been loaded with soiled clothing or the like. As the articles are washed with the solvent, the solvent is recirculated by the pump 7 through conduits 9 and 8 which together with the washing chamber 1 form a closed circuit of conduits. Appropriate valves may be operated to include a filter 10 in the conduit 8 for removal of insoluble dirt. Apart from this filtration, the recirculation of the liquid has the additional effect of improving the mechanical movement between liquid and articles. Upon termination of this washing step, the solvent liquid is either returned to the reservoir 6 or — if it is sufficiently contaminated — pumped by the pump 7 through the conduit 11 into a still 12. The articles are then spun for a short period.

When the solvent has been drained off, the washing chamber 1 is immediately filled with the aqueous liquid through the conduit 3 and active washing substance from the container 5 may be added simultaneously. The laundering step is then carried out in the washing chamber 1. The aqueous liquid then present in the washing chamber 1 is then heated by the steam jacket 2.

Where perchloroethylene (which is capable of forming an azetropic mixture with water, the azetropic mixture having a boiling point below that of water) serves as the solvent any residual solvent still present in the articles from the previous solvent treatment forms a single-phase liquid mixture with the aqueous washing liquid. The aqueous liquid is heated to the boiling point of the azeotropic mixture of perchloroethylene and water and to a temperature above that boiling point, the vapours evolved passing into the condenser 14 through a conduit 13. The vaporization may be optionally accelerated by connecting the washing chamber 1 to a vacuum pump 21 by which the vapours are forcibly delivered into the condenser 14 through a conduit 13*a*.

In the case of a solvent not capable of forming an azeotropic mixture with water, the solvent evaporates as soon as the temperature of the aqueous liquor exceeds the boiling point of that solvent.

The condensate obtained in the condenser 14 is fed to the water separator 15 where any free water is removed. Water (if any) is discharged through a conduit 16. The remaining condensate passes to an outlet of the water separator 15 connected to a conduit 18 and through a flow-meter 17 indicating the amount passing through per unit time.

As soon as the meter 17 indicates a flow value of zero or not exceeding a permissible predetermined value, the washing step may be stopped. The washing liquid is then drained off through conduit 4. The cleaned articles are subjected to a short spin and may then be safely withdrawn from the washing chamber 1, that is to say free from undesirable traces of solvent, or they may be re-washed with aqueous liquor as is usually the practice.

In the illustrated embodiment, a condenser 19 is connected in known manner to the distillation vessel or still 12. The condensate outlet of the condenser 19 is connected to a water separator 20 (which, when the condenser consists of an aqueous phase in addition to a solvent phase, separates the two phases from each other) the solvent outlet of which is in communication with the solvent reservoir.

There is also a conduit connecting the filter 10 with the still 12 so that liquid can be passed to the still therefrom.

In order to carry out the method embodying the invention an ordinary washing machine is provided with the added condenser 14, the flowmeter 17 and the means provided for connection of the conduits 8, 9 and 18, so that the machine say, in principle, be connected to any other available solvent-supplying device. It will be understood that the additional solvent-supplying

device may advantageously be directly included in the frame or housing of each individual machine, particularly since the additional costs incurred are still far below the costs of two separate machines required in the conventional method of preliminary cleaning with a solvent, quite apart from the aforementioned advantages, namely the resulting shorter time required for operation of the total process and the equipment used for carrying it out.

WHAT WE CLAIM IS:—

1. A method of washing one or more articles selected from articles of clothing, bed linen, underwear and similar articles comprising cleaning the one or more articles in a washing chamber with an organic solvent which is capable of forming an azeotropic mixture with water having a boiling point below that of water or itself has a boiling point below the boiling point of water, removing the bulk of the solvent, then in the same washing chamber washing the one or more articles still wet with the solvent, in an aqueous liquid at a temperature above the boiling point of the solvent or above the boiling point of the azeotropic mixture, condensing the vapour evolved, and after separating any free water monitoring the rate of flow of the remaining condensate and continuing the washing until the flow drops below a predetermined value.

3. A method according to claim 1, in which the pressure in the vapour space above the heated aqueous liquid is reduced during the washing step.

3. A method according to claim 1 or claim 2, in which the one or more articles are spin-dried after the solvent has been drained off from the washing chamber.

4. A method according to any one of the preceding claims, in which one or more washing ingredients, such as detergents, are added to the aqueous liquid.

5. A method according to claim 1, substantially as hereinbefore described with reference to and as shown in the accompanying drawing.

EDWARD EVANS & CO.,
53-64 Chancery Lane,
London, WC2A 1SD.
Agents for the Applicants.

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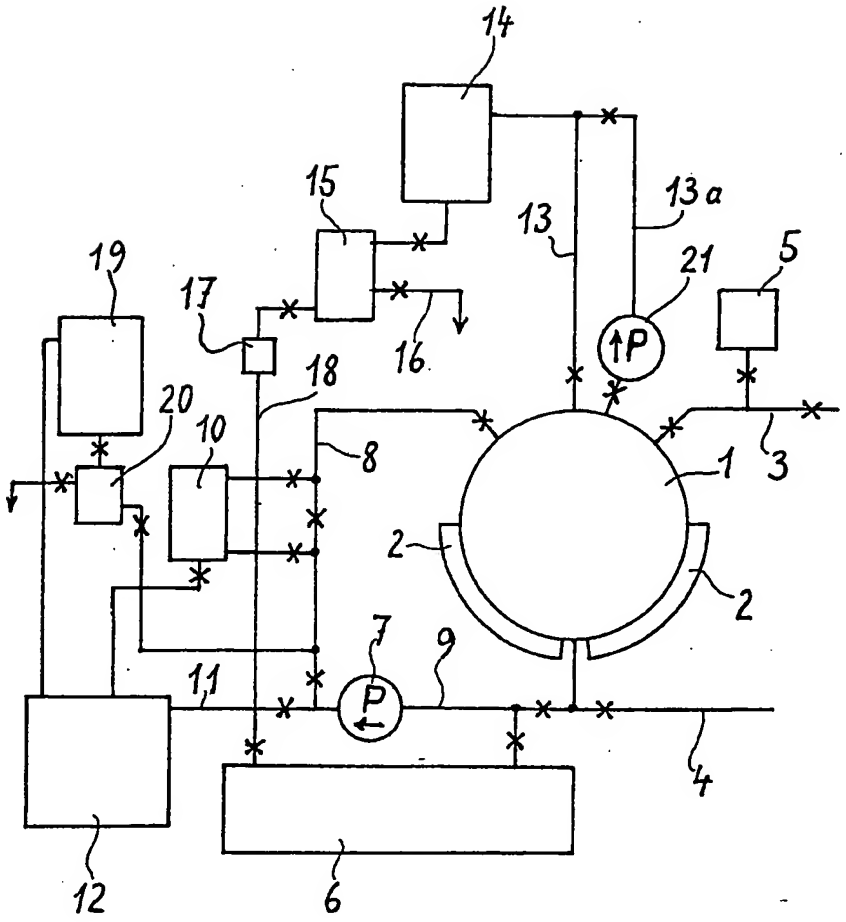

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The invention relates to the washing of, for example clothing, bed linen, underwear and similar articles with water in a washing chamber.

A large number of laundering methods of this kind are known. They have the advantage that the cleansing liquid is relatively cheap, but they also have the disadvantage that a certain greying of the cleaned articles (so-called "retrograde washing") cannot be avoided by adding adjuvant substances, and dirt which contains oil and grease can be detached from the articles to be cleaned to an only inadequate extent or can be removed therefrom only with the aid of special washing aids which have to be added to the liquid. The waste water is contaminated with the grease and oil-containing dirt thus dispersed in the liquid and can be separated therefrom only with difficulty. In order to overcome these disadvantages, it is known to subject the articles to a preliminary cleaning with conventional solvents in a dry-cleaning machine before they are laundered in a washing machine. In order to avoid losses of solvent and poisoning of the environment on the transfer of the articles to the washing machine, the previously cleaned articles have to be completely dried before they are transferred to the washing machine.

A method of avoiding the substantial expenditure for equipment, and in order to save time and personnel, is to treat the articles with a mixture of solvent and water in the form of an emulsion or micellar solution. This method has succeeded in practice. However, in this known method a marked greying cannot be avoided even by extended rinsing. On the other hand, the detachment of water-soluble substances by means of the emulsified quantity of water produces unsatisfactory results.

British Patent Specification No. 812,894 discloses the finishing of textiles by passing a width of textile material through a bath of hot water (water seal). In this method, the bulk of the solvent is removed by conventional means, for example squeezing rollers, before the width of textile material enters the water bath. The water serves merely as a means of facilitating evaporation of residual traces of solvent.

In a method of dyeing textiles in a mixture of solvent and water disclosed in German Offenlegungsschrift No. 1,931,353, undesirable water-soluble additives still present on the articles previously dyed with the dye dissolved in the water are removed from the textiles in a bath of heated water after the dyeing liquid has been drained off. Apart from the fact that that Offenlegungsschrift does not relate to the removal of water-soluble dirt, the articles are, before application of the heated bath of water, impregnated with a mixture of solvent and water in which the additives referred to are dissolved. The rinsing has merely the effect of diluting the existing aqueous solution.

It is therefore an object of the invention to try to overcome the disadvantages of the known art and to provide a method and apparatus requiring little expenditure for apparatus and affording a saving in time and personnel, and ensuring an improved washing effect, a markedly reduced greying and an increased brightening while simultaneously avoiding contamination of the waste water with oil and grease.

According to the invention there is

provided a method of washing one or more articles selected from articles of clothing, bed linen, underwear and similar articles, comprising cleaning the one or more articles in a washing chamber with an organic solvent which is capable of forming an azeotropic mixture with water having a boiling point below that of water or itself has a boiling point below the boiling point of water, removing the bulk of the solvent, when in the same washing chamber the one or more articles, still wet with the solvent, in an aqueous liquid at a temperature above the boiling point of the solvent or above the boiling point of the azeotropic mixture, condensing the vapour evolved, and after separating any free water monitoring the rate of flow of the remaining condensate and continuing the washing until the flow drops below a predetermined value.

Thus using the method of the invention, the articles, before being wetted with water, are initially cleaned in the same washing chamber wih an organic solvent, preferably with a halogenated hydrocarbon, for example perchloroethylene or trichlorotrifluorethylene, which is capable of forming an azeotropic mixture with water having a boiling point below that of water or which has a boiling point below the boiling point of water, without additional water; the articles still moist with solvent are then washed in the same washing machine without having previously been dried, in an aqueous liquid provided with a detergent, for example an active washing substance, a polyphosphate and optionally with an optical brightening or bleaching agent, at a temperature above the boiling point of the solvent or above the boiling point of the azeotropic mixture, until substantially no solvent evaporates from the liquid. This condition can be readily determined by condensing the vapour rising from the liquid in a condenser and measuring the rate of flow of the condensate from the condenser after the removal of any free water. The washing step may be terminated as soon as this rate of flow drops below a predetermined value. This can be readily measured and evaluated with the aid of a flowmeter. The articles may then be spin-dried or centrifuged and subsequently be withdrawn from the machine. During the heating of the washing liquor, the solvent escapes therefrom as vapour when its temperature exceeds the boiling point of the solvent or the azetropic boiling point. Thorough laundering requires, in any case, a temperature in the range 90-95°C, and evaporation of the solvent is thus always ensured in the presence of the halogenated hydrocarbons generally used for solvent cleaning.

Thus, in a method embodying the invention there is an active washing step in which, the dirt-dissolving capacity of the solvent, still present in the articles from the preceding dry-cleaning step, increases with increasing temperature of the water.

As compared with the known methods of washing, the method embodying the invention results in surprisingly little greying and a considerably improved brightening of the articles to be cleaned, both as compared with the results obtained in exclusive dry-cleaning and exclusive laundering and also as compared with the method of cleaning in a mixture of solvent and water. A better washing effect is obtained. First of all, the heating during the laundering step has the effect of improving the dirt-solving capacity of the solvent which is deliberately left on the articles previously treated with the solvent. As a result, substances of low solubility in normal solvent cleaning without heating of the liquor, are detached from the articles and removed. It has also been found that in most articles of clothing the solvent adhering to the inside and outside of the fibre and the dirt present in the solvent are gradually dislodged from the inside and outside of the fibre by the water during the washing step before the boiling point is reached. Upon evaporation of these last traces of solvent, the residual dirt initially still present remains in dispersed form in the water instead of remaining in or on the fibre. The expenditure for apparatus, the consumption of time and the personnel requirements are considerably below those in separate dry-cleaning and laundering processes carried out in different machines. The fact that exclusive "dry-cleaning" — that is to say cleaning in a completely anhydrous solvent — is carried out before the actual laundering step and that upon subsequent laundering a portion of the solvent is still present on the articles and thus contributes to an improved washing effect upon heating, is essential to the advantageous results obtained by the invention, particularly the surprisingly slight greying and the improved brightening as compared with the results obtained by application of the known washing methods.

An as complete as possible evaporation of the solvent during the laundering step, even in short-time laundering, for example for cleaning articles which are only slightly dirty, may be ensured in that means are provided so that the pressure in the vapour space above the heated aqueous liquid is reduced during the period of laundering. Furthermore, the articles may be spun for a short time after the solvent has been drained from the washing chamber to reduce the amount of solvent to be

evaporated during the subsequent laundering step. However, basically this is not absolutely necessary. As mentioned previously, a brightening, bleaching or active washing substances, known *per se* may advantageously be added to the aqueous liquor to assist the washing effect.

In the accompanying drawing is shown a simplified block diagram of a machine suitable for carrying out the method of the invention.

In the drawing the run of the individual conduits is indicated merely by lines and the individual valves and other shut-off elements are indicated simply by a switch symbol *x*. It will readily be apparent which particular shut-off elements are open and which shut-elements are closed during specific operating steps so that it is unnecessary to mention this in the following description.

Referring to the drawing, a washing chamber 1 is normally constructed as a drum housing containing a rotatable drum to be loaded with the articles. The washing chamber 1 is provided with a steam jacket 2 for heating the liquid. Water or aqueous liquid is supplied through a conduit 3 and discharged through a conduit 4. A container 5 contains an active washing substance or the like to be introduced into the aqueous liquid.

At the beginning of the operational process, solvent from a solvent reservoir 6 is pumped by a pump 7 through conduit 8 into the washing chamber 1 which has previously been loaded with soiled clothing or the like. As the articles are washed with the solvent, the solvent is recirculated by the pump 7 through conduits 9 and 8 which together with the washing chamber 1 form a closed circuit of conduits. Appropriate valves may be operated to include a filter 10 in the conduit 8 for removal of insoluble dirt. Apart from this filtration, the recirculation of the liquid has the additional effect of improving the mechanical movement between liquid and articles. Upon termination of this washing step, the solvent liquid is either returned to the reservoir 6 or — if it is sufficiently contaminated — pumped by the pump 7 through the conduit 11 into a still 12. The articles are then spun for a short period.

When the solvent has been drained off, the washing chamber 1 is immediately filled with the aqueous liquid through the conduit 3 and active washing substance from the container 5 may be added simultaneously. The laundering step is then carried out in the washing chamber 1. The aqueous liquid then present in the washing chamber 1 is then heated by the steam jacket 2.

Where perchloroethylene (which is capable of forming an azetropic mixture with water, the azetropic mixture having a boiling point below that of water) serves as the solvent any residual solvent still present in the articles from the previous solvent treatment forms a single-phase liquid mixture with the aqueous washing liquid. The aqueous liquid is heated to the boiling point of the azeotropic mixture of perchloroethylene and water and to a temperature above that boiling point, the vapours evolved passing into the condenser 14 through a conduit 13. The vaporization may be optionally accelerated by connecting the washing chamber 1 to a vacuum pump 21 by which the vapours are forcibly delivered into the condenser 14 through a conduit 13*a*.

In the case of a solvent not capable of forming an azeotropic mixture with water, the solvent evaporates as soon as the temperature of the aqueous liquor exceeds the boiling point of that solvent.

The condensate obtained in the condenser 14 is fed to the water separator 15 where any free water is removed. Water (if any) is discharged through a conduit 16. The remaining condensate passes to an outlet of the water separator 15 connected to a conduit 18 and through a flow-meter 17 indicating the amount passing through per unit time.

As soon as the meter 17 indicates a flow value of zero or not exceeding a permissible predetermined value, the washing step may be stopped. The washing liquid is then drained off through conduit 4. The cleaned articles are subjected to a short spin and may then be safely withdrawn from the washing chamber 1, that is to say free from undesirable traces of solvent, or they may be re-washed with aqueous liquor as is usually the practice.

In the illustrated embodiment, a condenser 19 is connected in known manner to the distillation vessel or still 12. The condensate outlet of the condenser 19 is connected to a water separator 20 (which, when the condenser consists of an aqueous phase in addition to a solvent phase, separates the two phases from each other) the solvent outlet of which is in communication with the solvent reservoir.

There is also a conduit connecting the filter 10 with the still 12 so that liquid can be passed to the still therefrom.

In order to carry out the method embodying the invention an ordinary washing machine is provided with the added condenser 14, the flowmeter 17 and the means provided for connection of the conduits 8, 9 and 18, so that the machine say, in principle, be connected to any other available solvent-supplying device. It will be understood that the additional solvent-supplying

device may advantageously be directly included in the frame or housing of each individual machine, particularly since the additional costs incurred are still far below the costs of two separate machines required in the conventional method of preliminary cleaning with a solvent, quite apart from the aforementioned advantages, namely the resulting shorter time required for operation of the total process and the equipment used for carrying it out.

WHAT WE CLAIM IS:—

1. A method of washing one or more articles selected from articles of clothing, bed linen, underwear and similar articles comprising cleaning the one or more articles in a washing chamber with an organic solvent which is capable of forming an azeotropic mixture with water having a boiling point below that of water or itself has a boiling point below the boiling point of water, removing the bulk of the solvent, then in the same washing chamber washing the one or more articles still wet with the solvent, in an aqueous liquid at a temperature above the boiling point of the solvent or above the boiling point of the azeotropic mixture, condensing the vapour evolved, and after separating any free water monitoring the rate of flow of the remaining condensate and continuing the washing until the flow drops below a predetermined value.

3. A method according to claim 1, in which the pressure in the vapour space above the heated aqueous liquid is reduced during the washing step.

3. A method according to claim 1 or claim 2, in which the one or more articles are spin-dried after the solvent has been drained off from the washing chamber.

4. A method according to any one of the preceding claims, in which one or more washing ingredients, such as detergents, are added to the aqueous liquid.

5. A method according to claim 1, substantially as hereinbefore described with reference to and as shown in the accompanying drawing.

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